Multimedia Systems
Lecture – 28

By

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Lossy Compression

- Entropy-coding or lossless compression has theoretical limits on the amount of compression that can be achieved.
- In certain situations, it might be necessary and appropriate to sacrifice some amount of information and thereby increase the compression obtained.
- For instance, human visual experiments on image perception have shown distortion introduced by image compression is still perceptually acceptable.
- In such cases, the original signal cannot be recovered in its entirety and there is a loss or distortion introduced.
- Most lossy compression schemes introduce a distortion because of quantizing the symbol code representations.
- Quantization is inherently lossy.

Transform Coding

- Transform coding techniques work by performing a mathematical transformation on the input signal that results in a different signal.
- These transformation changes the signal representation to a domain, which can result in reducing the signal entropy and, hence, the number of bits required to compress the signal.
- Transform coding techniques by themselves are not lossy; however, they frequently employ quantization after a transform.
- Transform techniques can be grouped as follows:
  - Frequency transforms—Discrete Fourier transforms, Hadamard transforms, Lapped Orthogonal transforms, Discrete Cosine transforms
  - Statistical transforms—Karhunen-Loeve transforms
  - Wavelet transforms—While similar to frequency transforms, these transforms work more efficiently because the input is transformed to a multiresolution frequency representation

Image Compression Techniques

- An explosion in the availability of digital images, because of the increase in numbers of digital imaging devices.
- The need to efficiently process and store images in digital form has motivated the development of many image compression standards.
- Image compression techniques can be purely lossless or lossy, but good image compression techniques often work as hybrid schemes.
- These schemes aim to get compression by typically analyzing the image data according to two important aspects:
  - Irrelevancy reduction: information associated with some pixels might be irrelevant and can, therefore, be removed. visual irrelevancy and application-specific irrelevancy.
  - Redundancy reduction: statistical redundancy because pixel values are not random but highly correlated, either in local areas or globally

- Local pixel correlation. Images are not a random collection of pixels, but exhibit a similar structure in local neighborhoods. Three magnified local areas are shown on the right

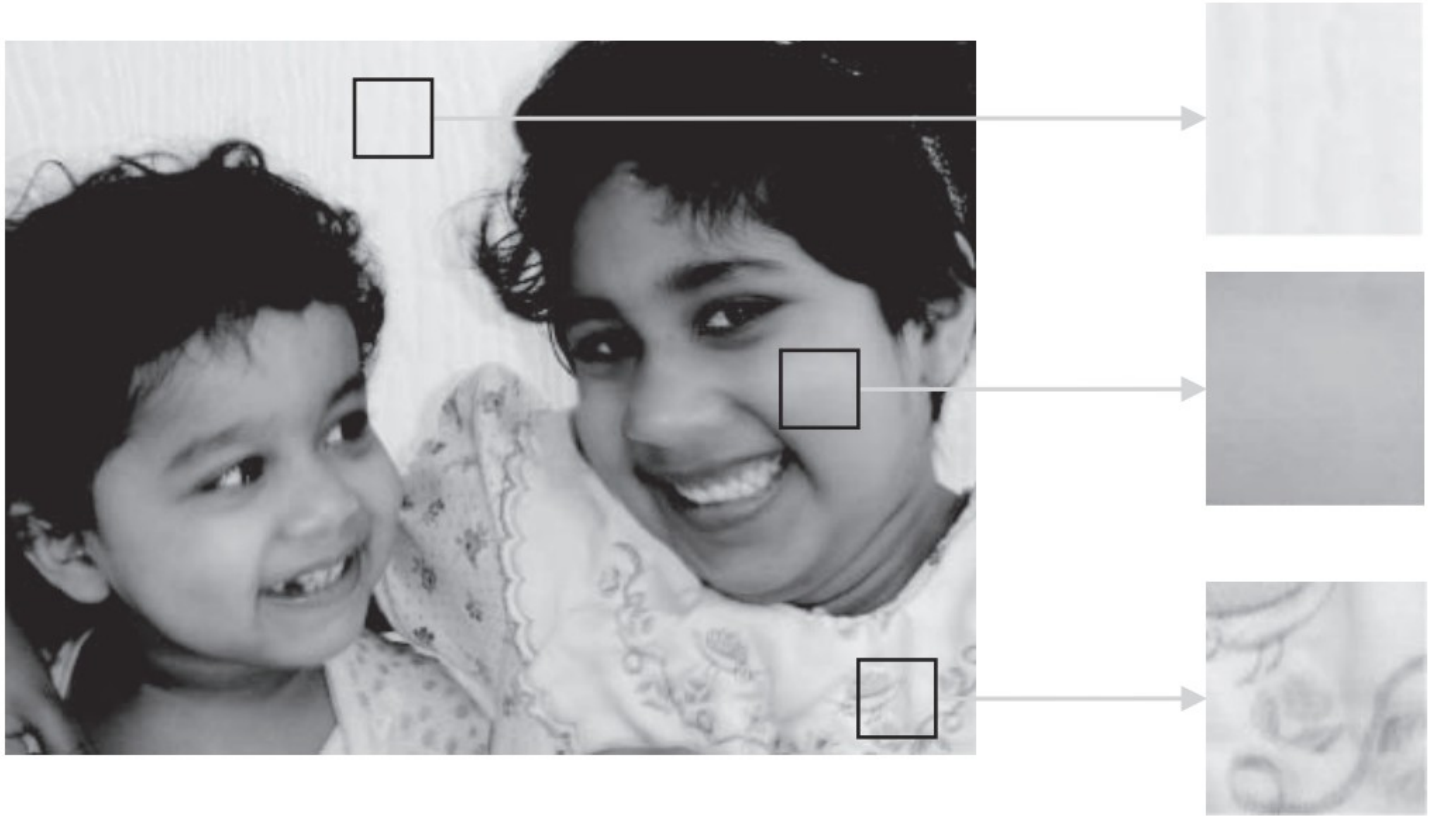
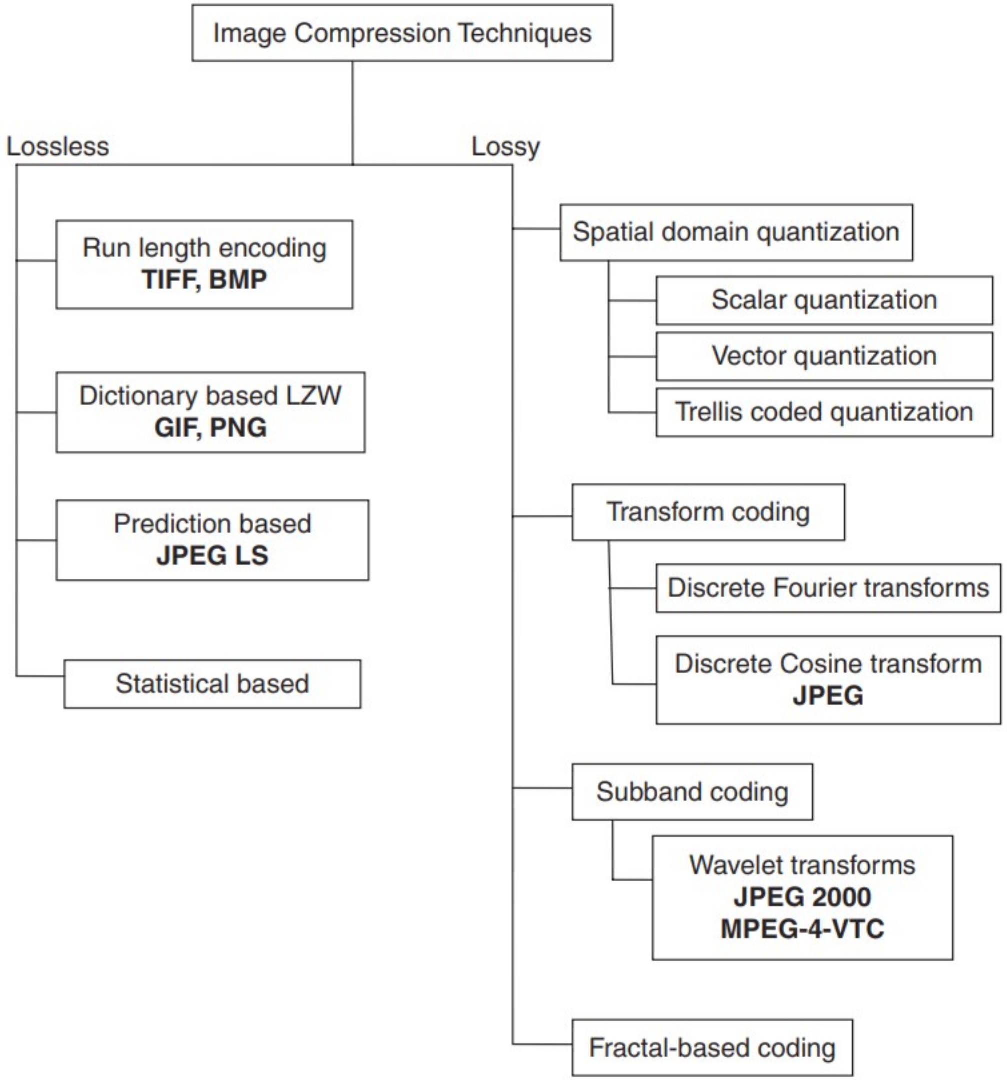


Image Compression Taxonomy



DCT Image Coding and the JPEG Standard

- The JPEG standard is based on a transform image coding technique that utilizes the Discrete Cosine transform (DCT).
- The DCT was chosen by the JPEG community because of its good frequency domain energy distribution for natural images, as well as its ease of adoption for efficient hardware-based computations.
- To understand how compression occurs in the JPEG pipeline, it is imperative that the DCT behavior be well understood.

Discrete Cosine Transform (DCT)

- The Discrete Cosine Transform (DCT), a widely used transform coding technique, is able to perform decorrelation of the input signal in a data-independent manner.

Definition of DCT

- Given a function f (i, j) over two integer variables i and j (a piece of an image), the 2D DCT transforms it into a new function F(u, v), with integer u and v running over the same range as i and j.
- The general definition of the transform is

$$F(u,v) = \frac{2\,C(u)\,C(v)}{\sqrt{MN}} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} \cos\frac{(2i+1)u\pi}{2M} \cos\frac{(2j+1)v\pi}{2N} f(i,j)$$

- where i, u = 0, 1,..., M − 1, j, v = 0, 1,..., N − 1, and the constants C(u) and C(v) are determined by

$$C(\xi) = \begin{cases} \frac{\sqrt{2}}{2} & \text{if } \xi = 0, \\ 1 & \text{otherwise.} \end{cases}$$